

WHAT IS CLAIMED IS:

1. A method for fabricating a semiconductor device which buries a tungsten plug in a hole provided in an insulating film, the method comprising the steps of:

forming a first tungsten film composing the tungsten plug over a wall surface of the hole and a bottom surface thereof; and

forming a second tungsten film composing the tungsten plug by using the first tungsten film as a seed layer and thereby filling up the hole therewith,

the step of forming the first tungsten film includes suppressing an average value of diameters of crystal grains of a portion of the first tungsten film which is formed at a bottom surface of the hole to 30 nm or less.

2. The method of claim 1, further comprising, prior to the step of forming the first tungsten film, the steps of:

forming an adhesion layer over the wall and bottom surfaces of the hole; and

performing a heat treatment with respect to the adhesion layer to clean a surface of the adhesion layer, wherein

the first tungsten film is formed on the cleaned surface of the adhesion layer.

3. The method of claim 2, wherein the step of performing the heat treatment and the step of forming the first tungsten film are performed continuously in the same reaction chamber without opening the reaction chamber to an atmosphere.

4. The method of claim 3, wherein the step of performing the heat treatment includes the step of introducing a heat treatment gas into the reaction chamber, raising a temperature in the reaction chamber over a specified period, and then exhausting the heat treatment gas from the reaction chamber.

5. The method of claim 4, wherein the heat treatment gas is composed of an argon gas and a hydrogen gas.

6. The method of claim 1, wherein the step of forming the first tungsten film is performed by CVD using a tungsten fluoride gas and a silicon hydride gas as raw material gases.

7. The method of claim 6, wherein a ratio of a flow rate of the tungsten fluoride gas to a flow rate of the silicon hydride gas is set to 8.4 or more.

8. The method of claim 1, wherein the step of forming the second tungsten film is performed by CVD using a tungsten fluoride gas and a hydrogen gas as raw material gases.

9. The method of claim 8, wherein a ratio of a flow rate of the tungsten fluoride gas to a flow rate of the hydrogen gas is set to 0.24 or more.

10. The method of claim 2, wherein the adhesion layer is a multilayer film composed of a titanium film and a titanium nitride film which are stacked successively in layers.

11. The method of claim 1, wherein the hole has an opening diameter of 0.18 μm or less.

12. A semiconductor device comprising a tungsten plug buried in a hole provided in an insulating film,

a portion of the tungsten plug which is formed on a bottom surface of the hole having a columnar structure,

an average value of a diameter of a bottom portion of the columnar structure being 30 nm or less.

13. The semiconductor device of claim 12, wherein an adhesion layer is provided between the insulating film and the tungsten plug.

14. The semiconductor device of claim 13, wherein the adhesion layer is a multilayer film composed of a titanium film and a titanium nitride film which are stacked successively in layers.

15. The semiconductor device of claim 12, wherein the hole has an opening diameter of 0.18 μm or less.